



A Successful Approach to *Salmonella* Surveillance: Using Student Interviewers to Improve Foodborne Disease Outbreak Response in New York City

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ABSTRACT

To improve the response to foodborne disease outbreaks, health departments should have adequate surveillance of such diseases. One key factor in accomplishing this is performance by health departments of timely hypothesis-generating interviews in cases of foodborne illness. In 2009, the New York City (NYC) Department of Health and Mental Hygiene (DOHMH) received funding from the Foodborne Diseases Centers for Outbreak Response Enhancement (FoodCORE) to hire students to perform all salmonellosis case-patient interviews. This study evaluated the effectiveness of implementing a student-interview model to conduct surveillance. Before enhancing surveillance, DOHMH interviewed only those salmonellosis case-patients associated with clusters or high-risk settings. Cases of salmonellosis diagnosed a year prior to enhancing surveillance (pre-enhanced surveillance) were compared with cases diagnosed the first and second years of enhanced surveillance. Overall, a higher proportion of case-patients were interviewed during year 1 (83%) and 2 (79%) of enhanced surveillance than during pre-enhanced surveillance (7%). When year 1 and 2 of enhanced and pre-enhanced surveillance were compared, case-patient interviews were more timely (median: 3, 2, and 21 days, respectively) and more case-patients answered all food-exposure questions (24%, 37%, and 2%, respectively). This approach to *Salmonella* surveillance appears to be successful and could be implemented in other health departments to cost-effectively expand epidemiologic capacity with a modest investment.

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INTRODUCTION

Non-typhoidal *Salmonella* is one of the leading causes of domestically acquired foodborne disease, with an estimated 1 million total cases, more than 19,000 hospitalizations, and 378 deaths occurring annually in the United States (U.S.) (14). Symptoms of salmonellosis include diarrhea, abdominal cramps, fever, headache, nausea, and vomiting (15). Although the illness often resolves with little treatment, more serious illness can occur, especially in infants, the elderly, and immunosuppressed individuals (15). *Salmonella* infection usually occurs because of ingestion of food or water that has been contaminated with *Salmonella* or contact with infected animals or a contaminated environment (2). Among bacterial pathogens, *Salmonella* accounted for the largest number of reported outbreaks in the United States from 2009 through 2010 (3). Effective surveillance of *Salmonella* is therefore critical to preventing and controlling foodborne disease outbreaks.

The New York City (NYC) Department of Health and Mental Hygiene (DOHMH) received 1,200 to 1,400 case reports of salmonellosis annually through passive surveillance from 2000 to 2010 (13). The Council to Improve Foodborne Outbreak Response (CIFOR) has prepared guidelines that describe the most common functions and activities in outbreak investigations, one of which is to interview all case-patients with a standardized questionnaire (9). Before 2009, DOHMH had little capacity to interview salmonellosis cases.

In 2009, the Centers for Disease Control and Prevention (CDC), with support from the US Department of Agriculture's Food Safety and Inspection Services (USDA FSIS) and the Association of Public Health Laboratories (APHL), began funding state and local health department projects to improve foodborne disease outbreak response (4). The goal was for each center to develop and improve methods of detecting, investigating, and controlling foodborne disease outbreaks. DOHMH was selected as one of the three pilot centers, and, in 2010, the project was expanded to include additional centers. CDC renamed this project the Foodborne Diseases Centers for Outbreak Response Enhancement (FoodCORE). DOHMH used FoodCORE funding to enhance *Salmonella* surveillance by hiring a team of student interns to perform hypothesis-generating interviews for all salmonellosis cases in NYC. The purpose of this study is to describe and evaluate this student-based surveillance approach at a local department of health (DOH). This evaluation demonstrates that a student-interview model is an effective method of surveillance.

MATERIALS AND METHODS

Both laboratories and health-care providers are required to report laboratory-confirmed cases of salmonellosis to DOHMH. Laboratories are mandated to report electronically, while health-care providers can report electronically or by mail, fax, or phone (11).

Pre-enhanced surveillance

Before September 1, 2009, DOHMH interviewed laboratory-confirmed cases of non-typhoidal salmonellosis only if the report indicated association with either a high-risk setting (daycare worker/

attendee, food handler, health care worker) or a cluster of salmonellosis cases that seemed to warrant additional investigation. DOHMH's Public Health Laboratory (PHL) identified clusters of *Salmonella* through pulsed-field gel electrophoresis (PFGE). PHL uploaded PFGE patterns to CDC's PulseNet database in which CDC, as well as state and some local health departments, can search for matches (5). DOHMH staff or a student intern interviewed patients over the phone, using questionnaires that varied before August 2009. DOHMH typically used cluster-specific targeted questionnaires that CDC prepared to interview cases associated with multi-state cluster investigations. For case-patients associated with high-risk transmission settings, a one-page general questionnaire was used that included questions related to but not limited to, clinical information as well as a brief food history and details on occupation. Case-patients associated with high-risk transmission settings may need to be excluded from work or from attending daycare to prevent additional illness from occurring (1). NYC daycare workers, daycare attendees, and healthcare workers are excluded from attending work or daycare based on criteria in the NYC health code (12). DOHMH staff excluded case-patients associated with high-risk transmission settings from work or attending daycare as needed. Interviewers used a language translation service over the phone to conduct interviews of patients who did not speak English. All completed case investigations were stored in paper format and were not entered into an electronic database.

Enhanced surveillance

In August 2009, DOHMH received FoodCORE funding to enhance *Salmonella* (non-typhoid) surveillance in NYC. Six student interns were hired to interview all salmonellosis patients by use of a hypothesis-generating questionnaire. In NYC, the questionnaire included questions designed to ascertain whether a person ate any of the foods on a long list of possible exposures, where the case-patient typically purchases food (i.e., grocery stores, restaurants), if the case-patient traveled or attended any events where there was food present during his/her incubation period, and if the patient had been exposed to animals. Such hypothesis-generating interviews are crucial in helping epidemiologists identify the exposures of particular interest and can ultimately help identify the source of an outbreak (6, 9).

This student-interview model was based on one called "Team Diarrhea" implemented at the Minnesota Department of Health (10). Students recruited from local graduate-level public health schools work approximately 20 hours per week during the academic year and 35 hours per week during the summer, rotating between workday and evening shifts. All students undergo a training process that includes an introduction to foodborne disease investigations, FoodCORE, and *Salmonella* surveillance in New York City. Students receive confidentiality training, an overview of the student evaluation process, and a review of the goals and expectations of working on this project.

Case investigations began with students entering data on newly-reported salmonellosis cases into Microsoft Access, where the team tracks the status of the investigation. Students contacted case-patients by phone and administered hypothesis-generating questionnaires consisting of questions on where case-patients typically purchased food, a 7-day food history, travel history, animal exposure, clinical information, and demographic information. The original hypothesis-

generating questionnaire used beginning September 1, 2009 included 66 specific food item questions (e.g., “In the 7 days before you got sick, did you eat chicken?”). On August 15, 2011, the hypothesis-generating interview was updated to incorporate core elements from a national hypothesis-generating questionnaire developed by a working group of epidemiologists from CDC and state health departments, which expanded the questionnaire to include 122 food item questions as well as various other exposure questions on topics such as animal contact or travel history. If a case-patient did not speak English, the interviewer utilized a language translation service to complete the interview.

Students performed either a standard or a limited interview. Limited interviews were conducted for patients who traveled internationally during their entire incubation period or were infants (less than 6 months old) who were consuming only formula or breast milk. In these instances, an abbreviated list of relevant exposures was asked. For standard interviews, the interviewer attempted to ask every question on the questionnaire. Cases associated with high-risk transmission settings were excluded from work or attending daycare as needed. Students made 3 attempts to contact each case-patient by phone, with at least one attempt after 5 p.m. If there was no response, the students mailed a letter to the case-patient asking him/her to call DOHMH. If the initial report contained incorrect contact information for the case-patient, the case-patient’s health-care provider was contacted to obtain updated contact information. Once an investigation was complete, all data collected during the course of the case investigation was entered into a Microsoft Access database.

SURVEILLANCE EVALUATION METHODS

Laboratory-confirmed cases of salmonellosis (non-typhoid) diagnosed from September 1, 2008 through August 31, 2009 (pre-enhanced surveillance) were compared with cases diagnosed from September 1, 2009 through August 31, 2010 (enhanced surveillance year 1) and September 1, 2010 through August 31, 2011 (enhanced surveillance year 2). This analysis included all case-patients residing in NYC reported to the DOHMH through passive surveillance. A total of 8 cases were excluded from the analysis (1 case during year 1 and 7 cases during year 2 of enhanced surveillance) because these cases were identified during the course of an outbreak investigation of unknown etiology in which DOHMH interviewed the case-patient and arranged for specimen collection and testing. The *Salmonella* results became available only after these case-patient interviews were conducted by use of a questionnaire with exposures related to the outbreak investigation and not the hypothesis-generating questionnaire. *Salmonella* surveillance data were analyzed using SAS version 9.1 (SAS Institute, Inc., North Carolina).

Variables included in this analysis were timeliness of interviews and completeness of demographic data and food-exposure history. Timeliness of interviews was assessed by calculating the median number of days between a case report date and the date on which the case-patient was interviewed. The median timeliness of the first interview attempt was calculated from the date of case report to date of first interview attempt, regardless of whether the case-patient was

interviewed during the attempt. Before enhanced surveillance, the date of the first interview attempt was not captured. All timeliness calculations include weekends and holidays.

Case-patients with complete demographic information were those for whom first and last name, date of birth, address, phone number, sex, race, and ethnicity information were all obtained. Race and ethnicity fields were considered complete even when case-patients reported “Unknown” to these variables.

To determine food exposure completeness, the total number of food exposure questions for each case-patient interview and the number of food exposure questions that were complete were counted. Interviews for which all food exposure questions were filled in were considered complete food exposure interviews. The percentage of questionnaires with complete food histories was calculated by dividing the total number of interviews with complete food sections by the total number of cases. Case-patients with diagnosis dates during pre-enhanced surveillance were interviewed with various questionnaires, depending on their association with a cluster or a high-risk setting. During enhanced surveillance, case-patients with complete food-exposure information were those who answered all 66 food item questions from the original hypothesis-generating questionnaire or all 122 food item questions from the updated questionnaire used during the 2nd year of enhanced surveillance. A comparison of the proportion of case-patients identified as being associated with a high-risk setting was also performed.

An analysis of data collected only during enhanced surveillance and not during pre-enhanced surveillance was also performed. Variables included in this analysis were interview attempts resulting in an interview, letters sent to case-patients requesting an interview, interviews performed after a letter requesting interview was sent to the case-patient, case investigations in which follow-up with a health-care provider was performed to obtain contact information for the case-patient, language of interview, median duration of the interview in minutes, and reasons why case-patients were not interviewed.

RESULTS

Pre-enhanced compared with enhanced surveillance

During pre-enhanced surveillance, 1,255 salmonellosis cases were reported to the DOHMH, compared with 1,290 cases during year 1 and 1,176 cases during year 2 of enhanced surveillance (**Table 1**). A higher proportion of case-patients were interviewed during years 1 (83%) and 2 (79%) of enhanced surveillance than during pre-enhanced (7%) surveillance. Case-patient interviews were timelier during year 1 and year 2 of enhanced than during pre-enhanced surveillance (median of 3, 2, and 21 days, respectively); timeliness of case-patient interviews also improved from year 1 to year 2 of enhanced surveillance. In addition to the median time for interview completion decreasing, the median time of the first interview contact attempt decreased from 1 day within receipt of the case report (year 1) to the same day the DOHMH received the report (year 2).

TABLE 1. A comparison of pre-enhanced *Salmonella* surveillance at the New York City Department of Health and Mental Hygiene and enhanced (DOHMH), September 1, 2008 through August 31, 2011

	Pre-Enhanced Surveillance: September 1, 2008– August 31, 2009	Enhanced Year 1: September 1, 2009– August 31, 2010	Enhanced Year 2: September 1, 2010– August 31, 2011
Total Cases N	1,255	1,290	1,176
Total interviewed ^a N (%)	92 (7)	1,070 (83)	930 (79)
Complete Demographic Information ^{a,b} N (%)	52 (4)	1,045 (81)	920 (78)
Complete Food History ^{a,c} N (%)	21 (2)	306 (24)	439 (37)
Median Interview Timeliness ^d (Days)	21	3	2
Median Interview Attempt Timeliness ^e (Days)	NA	1	0

^aTotal cases used as the denominator.

^bCase-patients with complete demographic information were those with first and last name, date of birth, address, phone number, sex, race, and ethnicity information. Race and ethnicity fields were considered complete even when case-patients reported “Unknown” for these variables.

^cDuring enhanced surveillance, food exposure questions were not asked to case-patients who travelled internationally during their entire incubation period or were infants (< 6 months old) who consumed only formula or breast milk.

^dInterview timeliness was calculated as the days between a case report date and date the case-patient was interviewed.

^eInterview attempt timeliness was calculated as the days between case report date and date an interview attempt was made. Interview attempt date was not captured during pre-enhanced surveillance.

More complete demographic information was collected for cases diagnosed during enhanced surveillance than during pre-enhanced surveillance (Table 1). Of cases interviewed during the study period, more complete food-exposure information was collected during enhanced than during pre-enhanced surveillance. When year 1 and year 2 of enhanced surveillance were compared, food-exposure completeness improved during year 2, even though more than 50 food-exposure questions had been added to the hypothesis-generating questionnaire. Many of the questionnaires were not entirely complete during year 1 and 2 of enhanced surveillance; however, 29% (year 1) and 28% (year 2) of these interviews were limited interviews that did not contain food exposure questions. Of the standard interviews, the majority of these

questionnaires had less than 10 fields with missing information for food exposures (87% and 92% for years 1 and 2 respectively). A greater proportion of cases associated with a high-risk setting were identified (4% year 1, 5% year 2) during enhanced surveillance than during pre-enhanced surveillance (0.3%).

Enhanced surveillance

During enhanced surveillance, the majority of interviews were performed at the first case-patient contact attempt (62% year 1, 64% year 2) (Table 2). Letters requesting an interview were sent to 21% (year 1) and 24% (year 2) of case-patients, of which 35% (year 1)

TABLE 2. Patient disposition data for enhanced *Salmonella* surveillance at the New York City Department of Health and Mental Hygiene (DOHMH), September 1, 2009 through August 31, 2011

	Enhanced Year 1: September 1, 2009– August 31, 2010 N (%)	Enhanced Year 2: September 1, 2010– August 31, 2011 N (%)
Total Cases	1,290	1,176
Total interviewed ^a	1,070 (83)	930 (79)
Interviewed at 1st call attempt ^b	664 (62)	595 (64)
Interviewed at 2nd call attempt ^b	157 (15)	166 (18)
Interviewed at 3 or more call attempts ^b	150 (14)	125 (13)
Interview date not recorded ^b	98 (9)	44 (5)
Letter sent to patient requesting interview ^a	265 (21)	278 (24)
Interviews performed after a letter requesting interview was sent ^c	94 (35)	94 (34)
Provider called to obtain contact information for patient ^a	83 (6)	176 (15)

^aTotal case-patients was used as the denominator.

^bTotal case-patients interviewed was used as the denominator.

^cTotal case-patients to whom a letter requesting interview was sent was used as the denominator.

and 34% (year 2) resulted in an interview. Students called healthcare providers for additional contact information for 6% (year 1) and 15% (year 2) of case-patients. Of the case-patients who were not interviewed during enhanced surveillance, the main reasons for no interview were that students were unable to reach the case-patient or that the case-patient was lost to follow-up (87% year 1 and 88% year 2). Only a small proportion of case-patients refused to be interviewed (7% year 1 and 10% year 2).

During enhanced surveillance, the majority of interviews were conducted in English (70% year 1, 64% year 2); however, interviews were also conducted in Spanish (11% year 1, 13% year 2) and Chinese (8% year 1 and year 2). Other languages in which interviews were conducted included, but were not limited to, Bengali, Russian, Polish, Albanian, Arabic, French, Hebrew, Japanese, and Greek. The median duration of patient interviews increased from year 1 to year 2 (23 versus 25 minutes, respectively) with the addition of exposure questions included in the hypothesis-generating questionnaire. During both year 1

and year 2, the median duration was greater for interviews conducted in a language other than English (30 and 31 minutes, respectively) than for those conducted in English (21 and 24 minutes, respectively).

DISCUSSION

FoodCORE funding allowed DOHMH to implement a student-interview model for improving foodborne disease outbreak investigations. By hiring six student interns, DOHMH dramatically increased the proportion of salmonellosis case-patients interviewed and performed more timely interviews, thereby capturing more complete food-exposure information.

Having complete and timely interviews allowed DOHMH to improve participation in multi-state cluster investigations and identify exposures associated with these clusters. During a multi-state cluster investigation of *Salmonella* Heidelberg infection, the NYC student

team was instrumental in identifying Kosher broiled chicken liver as the contaminated food item of interest (7). The team's hard work ultimately led to a product recall that prevented additional illness from occurring (8). The students also have provided surge capacity during outbreak investigations; before enhanced surveillance, full-time staff would be pulled from their regular duties to aid in these investigations, affecting the continuity of routine DOHMH operations. When few full-time staff resources are available to conduct adequate hypothesis-generating interviews for foodborne diseases, having student interns perform *Salmonella* surveillance activities is a cost-effective method. Student interns work part-time, are paid between \$11.36 and \$12.96 per hour, and do not receive benefits. The DOHMH provides training, experience, leadership skills, thesis mentorship, and frequently job opportunities upon graduation. Additionally, this student-based model is a mechanism for teaching future leaders of public health the skills necessary for foodborne disease surveillance, outbreak response and prevention, and the importance of food safety. Many of the students who have worked on enhanced *Salmonella* surveillance at DOHMH have gone on to pursue careers in public health either at a local health department, at CDC, or in academia.

Although student interns do build capacity, they require increased oversight and administrative work. Several protocols were needed to address topics such as interviewing techniques, data entry methods, and proper attire for a work environment. Students often intern with the DOHMH for only a year, so that staff must regularly recruit, hire, and train new students. A written evaluation process for the student team has been developed that allows a staff member to meet with each student twice a year to review his/her performance. A team meeting is held three times a year to brainstorm ways to improve *Salmonella* surveillance.

This surveillance evaluation has certain limitations. Before enhanced surveillance, DOHMH kept all salmonellosis investigations on paper and did not enter data into a database, and it is possible that some case investigations were misplaced or not filed appropriately and therefore not included in this analysis. Another limitation to this analysis is that various questionnaires were used for *Salmonella* surveillance during the pre-enhanced surveillance period, making a comparison between pre- and enhanced surveillance challenging.

Despite these challenges, using a student-interview model has proven to be an efficient way for DOHMH to improve *Salmonella* surveillance dramatically. Such a model could be beneficial to other local or state health departments to expand capacity in a cost-effective way.

Future goals of enhanced *Salmonella* surveillance in NYC are to continue to improve the timeliness and completeness of salmonellosis case investigations as well as to expand DOHMH laboratory capacity. Laboratory capacity enhancement will focus specifically on improving the timeliness of *Salmonella* serotyping and PFGE pattern analysis for *Salmonella* isolates, which could lead to better cluster detection.

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